

Appendix C

Cryostat Stress Due to Internal Helium Pressure

Helium pressure can rise substantially in the cryostat from coil quenching, loss of vacuum, or both occurring simultaneously. The pressure can be expected to rise to 3 atm absolute with a complete loss of vacuum. Assuming that no helium had vented the system, an ensuing instantaneous magnet quench depositing all 11.5 MJ into one coil would only raise the pressure to 6.7 atm (100 psia). A quench with vacuum would cause at the most a 4.4 atm (65 psia) pressure increase. The axisymmetric ANSYS model was run with a 100 psi internal pressure load. Figures 88 to 91 show the results. Maximum stress intensity is 7273 psi in the bottom annular plate. This stress is slightly higher than the peak stress intensity of 6299 psi found at the face of the bottom cryostat closure weld. Assume the worse case of helium pressure and full electromagnetic loading. At a cross section through the weld we then get,

100 psi Internal Pressure

	Root of Weld	Face of Weld	Avg
S_x	5010	-5710	-350
S_y	2541	501	1521
S_z	2326	-1283	522
SI	3692	6299	

$$P_m (\text{SI}) = 1521 + 350 = 1871 < S_m = 58000$$

$$P_l + P_b (\text{SI}) = 5710 + 501 = 6211 < 1.5 S_m = 87000$$

= 5010 - 2326 = 2684 \text{ at the root of the weld}

$$P_l + P_b + Q (\text{SI}) = 6299$$

With only internal pressure the code is violated with a helium pressure of 1400 psi.

Using the results from Section 12 on the cryostat summary, we get the following result.

100 psi internal pressure +
all other loads except radial decentering

	Root of Weld	Face of Weld	Avg
S_x	29750	-33780	-2015
S_y	14170	2881	8526
S_z	18890	-2246	8322

$$P_m \text{ (SI)} = 10540 < S_m = 58000$$

$$P_1 + P_b \text{ (SI)} = 36660 < 1.5 S_m = 87000$$

= 15580 at the root of the weld

$$P_1 + P_b + Q \text{ (SI)} < 21590 < 3 S_m \text{ at the root}$$

$< 37180 < 3 S_m$ at the face

where a worse case addition was made for $P_1 + P_b + Q$ using stress intensities rather than computing stress intensities from component addition. It is found that the code is satisfied up to an internal pressure of ~ 850 psi when the cryostat is under full electromagnet loading. In practice high helium pressures will never be found with full electromagnetic loading since the current will be dropping rapidly due to coil quench and energy removal in the dump resistor.

ANSYS

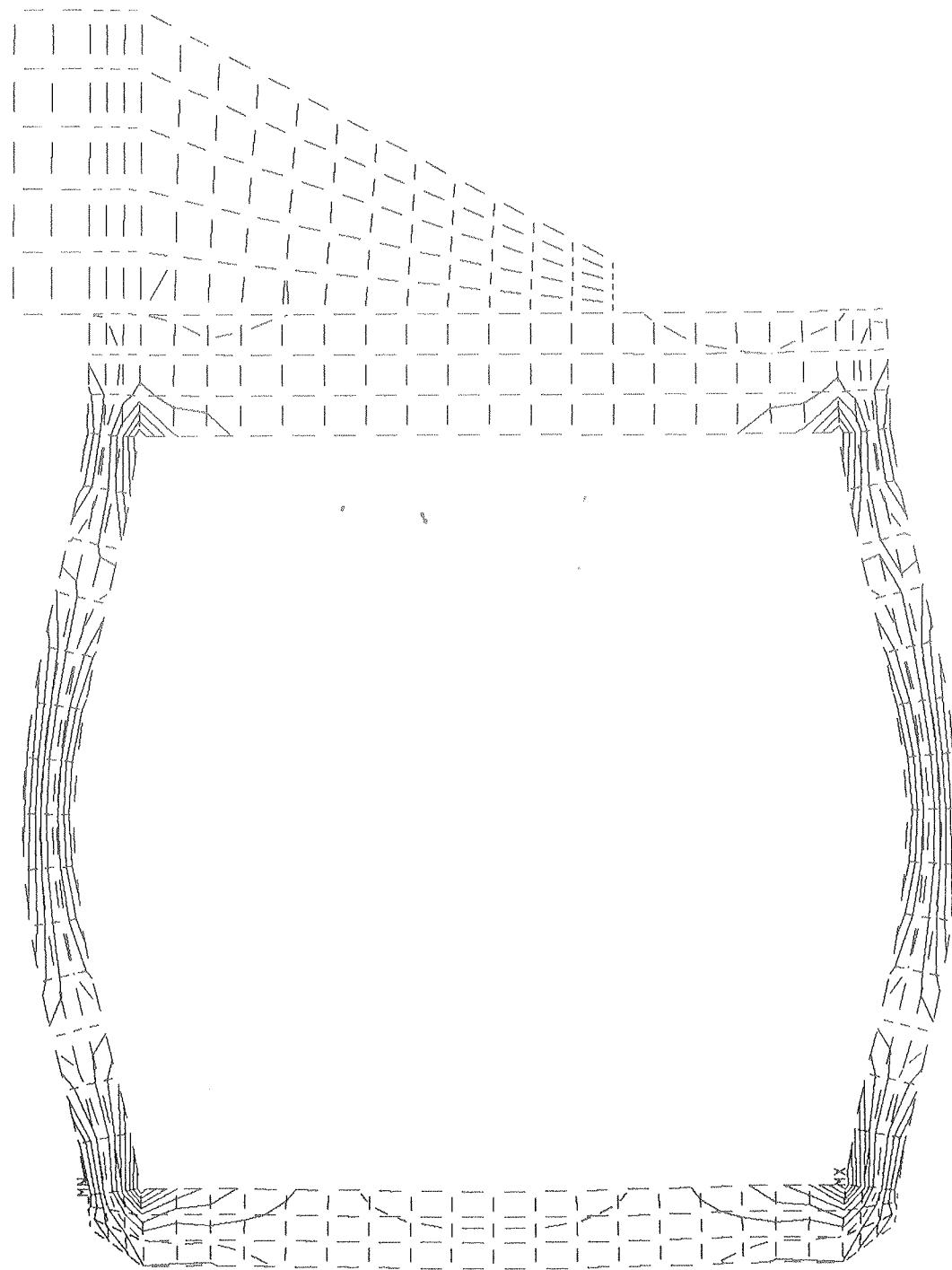
84 / 9/23
18.5856
PLOT NO. 3

POST1
STEP=1
ITER=1
STRESS PLOT
SZ

ORIG SCALING

ZV=1
DIST=8.94
XF=34.9
YF=.5
DMAX=.0044
DSCH=218
MX=3101
MN=-1886
INC=400

Fig - 88



ANSYS

84 / 9/23

18.5858

PLOT NO. 4

POST1

STEP=1

ITER=1

STRESS PLOT

SX

ORIG SCALING

ZV=1

DIST=8.94

XF=31.9

YF=.5

BMAX=.0041

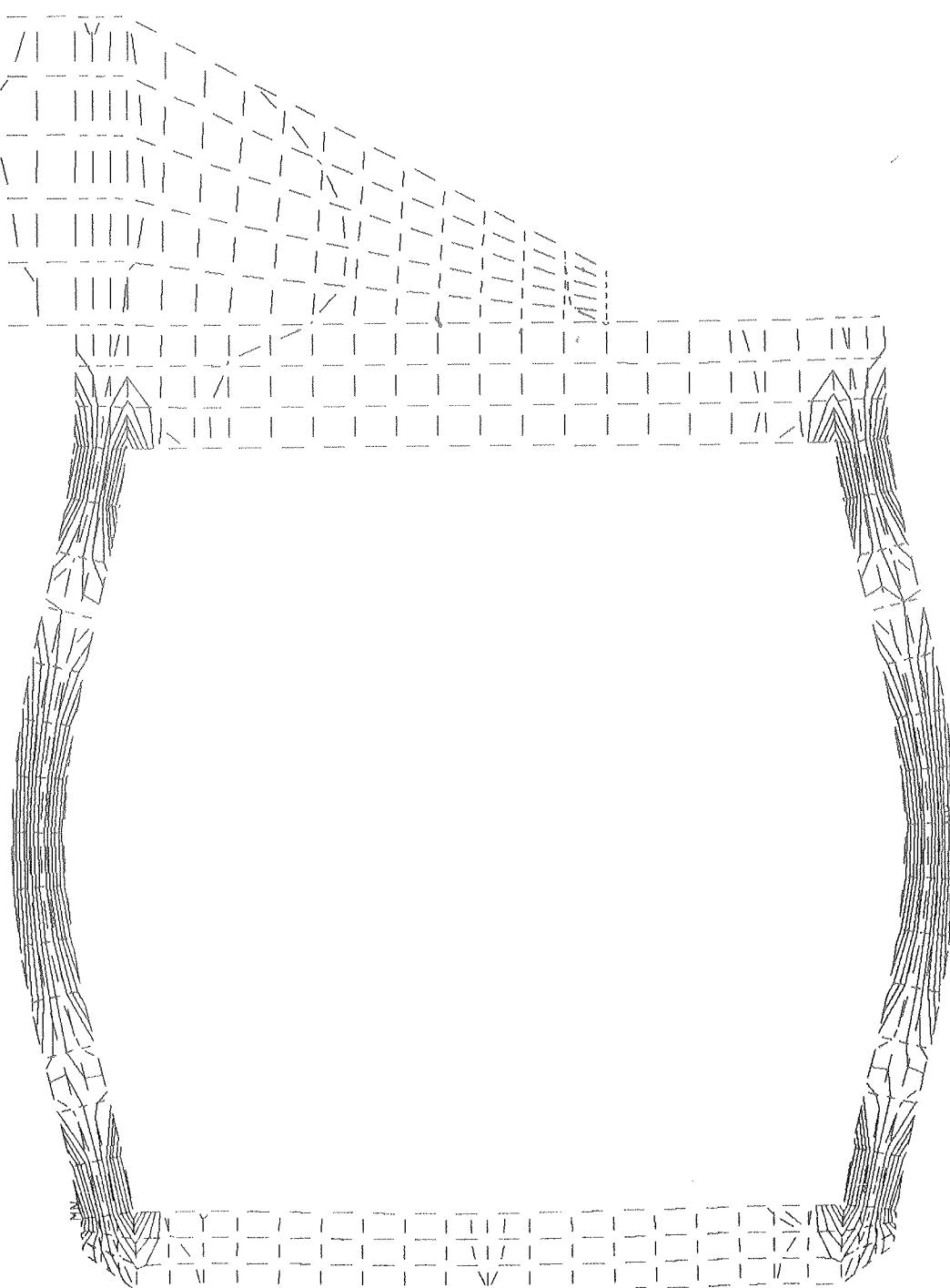
DSCA=21.8

MX=6718

MN=-6101

INC=800

Fig. 89



ANSYS
84/ 9/23
18.5864
PLOT NO. 5
POST1
STEP=1
ITER=1
STRESS PLOT
SY

ORIG SCALING

ZV=1
DIST=8.94
XF=31.9
YF=.5
DMAX=.0041
DSCA=218
MX=5277
MN=-2548
INC=500

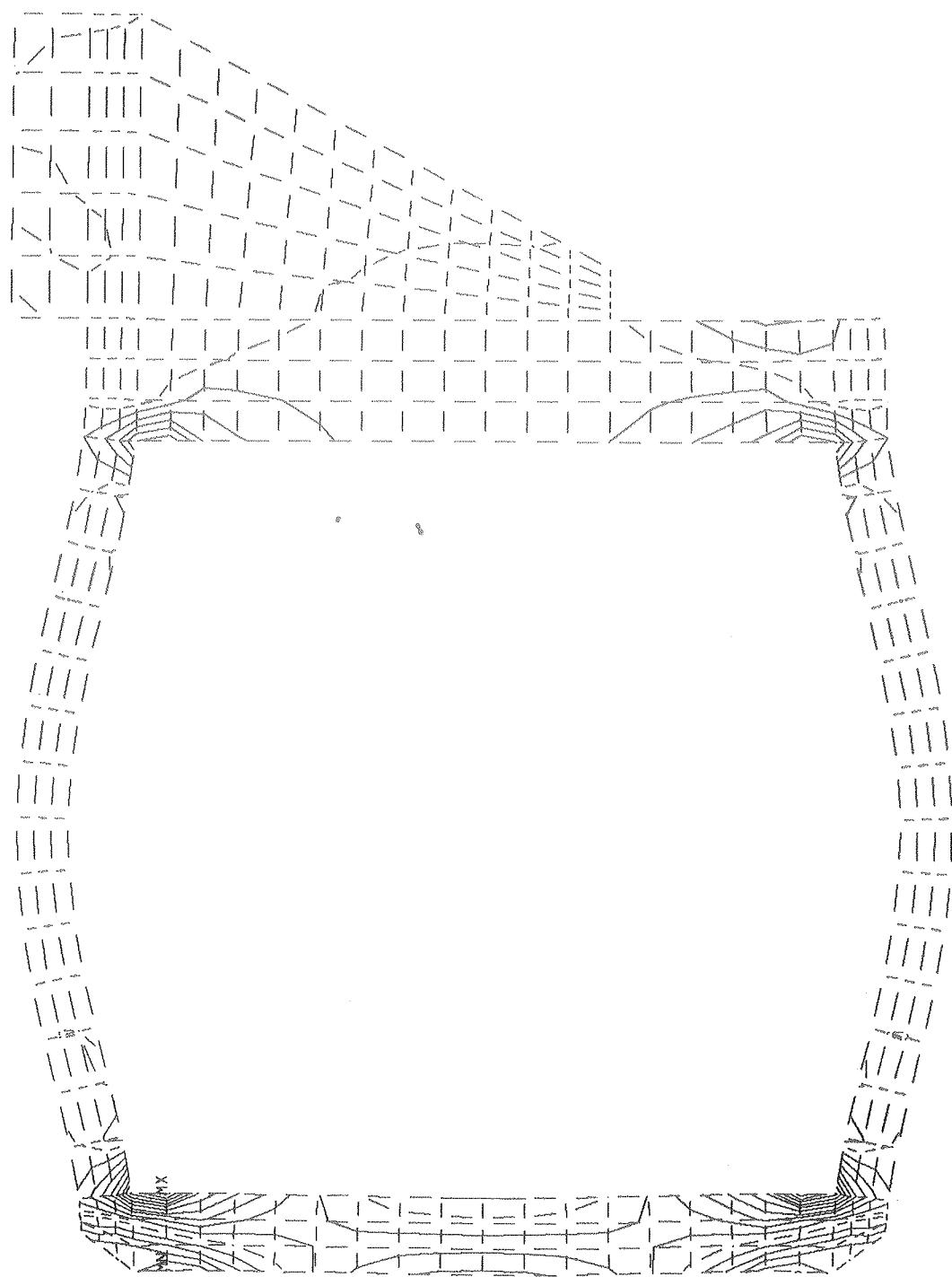


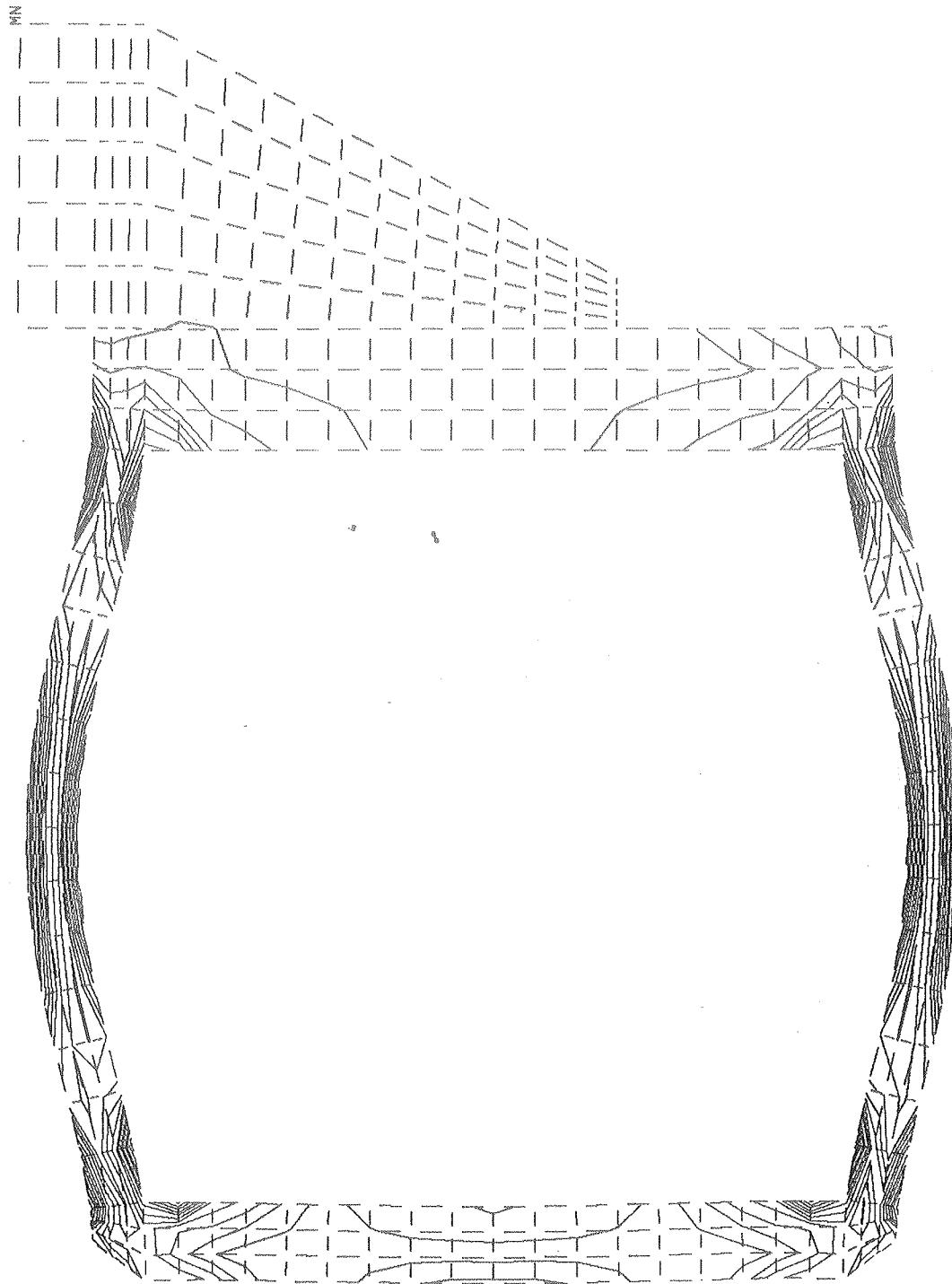
Fig 90

ANSYS

84/ 9/23
18.5872
PLOT NO. 7
POST1
STEP=1
ITER=1
STRESS PLOT
SI

ORIG SCALING

ZV=1
DIST=8.94
XF=31.9
YF=.5
DMAX=.0041
DSCH=218
NX=7273
MN=.208
INC=500



30 INCH MAGNET 100 PSI INTERNAL PRESSURE